CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

MONITORING AND REPORTING PROGRAM NO. R5-2015-0012-XXX
FOR
IN-SITU GROUNDWATER REMEDIATION
AND DISCHARGE OF TREATED GROUNDWATER TO LAND

This Monitoring and Reporting Program (MRP) describes requirements for monitoring a groundwater remediation pilot study for Buckeye Landfill, Lake Boulevard, Shasta Lake, California (**Figure 1**). This MRP is issued pursuant to Water Code Section 13267. The Discharger shall not implement any changes to this MRP unless and until a revised MRP is issued by the Executive Officer. As appropriate, California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board) staff shall approve specific sample station locations prior to implementation of sampling activities.

This MRP is for Phase 2 of the ozone-treatment system pilot study. The MRP will be revised if Phase 2 of the pilot study is shown to successfully treat groundwater contamination and a full-scale ozone sparge system is implemented. All samples should be representative of the volume and nature of the discharge or matrix of material sampled. The time, date, and location of each grab sample shall be recorded on the sample chain of custody form.

GROUNDWATER MONITORING

As shown on **Figure 2**, there are three groundwater monitoring wells and one ozone-injection point associated with Phase 2 of the ozone treatment pilot study for this site. Sample collection and analysis shall follow standard EPA protocol. Sampling performed as part of the pilot study shall follow procedures established in the 20 January 2017 *Sample Collection and Analysis Plan*.

The monitoring wells shall be sampled according to the schedule in **Table 1** and the samples analyzed by the methods in **Table 2**.

FIELD SAMPLING

In addition to the above sampling and laboratory analyses, field sampling and analysis shall be conducted each time a monitoring well or injection point is sampled. The sampling and analysis of field parameters shall be as specified in **Table 3**. All wells that are purged shall be purged until pH, temperature, conductivity and dissolved oxygen are within 10% of the previous value. Field test instruments (such as those used to test pH and dissolved oxygen) may be used provided that:

1. The operator is trained in proper use and maintenance of the instruments;
2. The instruments are calibrated prior to each monitoring event;
3. Instruments are serviced and/or calibrated by the manufacturer at the recommended frequency; and

4. Field calibration reports are submitted as described in item (b) of the "Reporting" section of this MRP.

Table 1: Sampling Frequency and Constituent Suite

Constituent Sampling Frequency	Well Number (Monitoring Objective)			
	B-1 (Compliance)	**B-2 (Compliance)**	**B-4 (Background)**	**TZ-1 (Treatment Zone)**
Pre-test, then weekly	Groundwater elevation (GWE), oxidation-reduction potential (ORP), electrical conductivity (EC), dissolved oxygen (DO), pH, temperature	GWE, ORP, EC, DO, pH, temperature	GWE, ORP, EC, DO, pH, temperature	GWE, ORP, EC, DO, pH, temperature
Pre-test, monthly during injection, 90, 180, 270 and 360 days after ozone injection completion	Volatile organic compounds (VOCs); 1,4-dioxane; methane; dissolved ferrous iron; chromium VI	VOCs; 1,4-dioxane; methane; dissolved ferrous iron; chromium VI	VOCs; 1,4-dioxane; methane; dissolved ferrous iron; chromium VI	VOCs, 1,4-dioxane; methane, dissolved ferrous iron, chromium VI
Pre-test and after final ozone injection	--	--	Per- and polyfluoroalkyl substances (PFAS)	PFAS

Table 2: Analytical Methods

Constituent	Method	Maximum Practical Quantitation Limit (µg/L)
Volatile Organic Compounds	EPA 8020 or 8260B	0.5
1-4 dioxane	EPA 8270(SIM)	1
Methane	Modified EPA 602	0.1
Dissolved Ferrous Iron	SM3500	100
Hexavalent Chromium	EPA 7199	1
Per- and polyfluoroalkyl substances (PFAS)	EPA 537 (Mod)	2 to 20 ng/L

Table 3: Field Sampling Requirements

Parameters	Units	Practical Quantitation Limit	Analytical Method
Groundwater Elevation	feet, mean sea level	0.01 feet	Measurement
Oxidation-Reduction Potential	millivolts	10 millivolts	Field Meter
Electrical Conductivity	µmhos/cm^2	50 µS/cm^2	Field Meter
Dissolved Oxygen	milligrams per liter	0.2 mg/L	Field Meter
pH	standard pH units	0.1 units	Field Meter
Temperature	degrees Fahrenheit or Celsius	0.1 degrees	Field Meter

IN-SITU DISCHARGE MONITORING

The Discharger shall monitor daily the discharge of ozone that is injected into the groundwater according to the requirements specified in **Table 4**. Ozone injection quantities shall be recorded, along with information regarding the time period over which ozone was injected into the aquifer.

Table 4: Discharge Monitoring Requirements

Parameters	Units	Type of Sample
Ozone Added	26 grams per day	Calculated

AMENDMENT ANALYSIS

Analysis of ozone is not applicable during the pilot study.

ESTABLISHMENT OF BACKGROUND CONCENTRATION VALUES

Pre-ozone treatment groundwater “background” values in pilot-study monitoring wells B-2 and B-4, including concentrations for pH, electrical conductivity (EC), TBA, and 1,4-dioxane, were determined following the procedures found in California Code of Regulations, title 27, Section 20415(e)(10). **Table 5** presents the background values, derived from samples collected between August 2013 through March 2020, because the data reflects recent conditions. The reported values for 1,4-dioxane during this timeframe were obtained using U.S. EPA Method 8260B; this MRP requires that 1,4-dioxane concentrations be assessed using U.S. EPA Method 8270SIM. Chromium VI has been non-detect [<7 micrograms per liter (µg/L)] since 2009. TBA and 1,4-dioxane background values were derived from the mean concentration measured in these wells during this timeframe. A one-time PFAS sampling event, conducted in November 2019 as required by Water Code

13267 Order WQ 2019-0006-DWQ, indicated detections of two PFAS constituents in groundwater monitoring well B-4, PFOA at 280 nanograms per liter (ng/L) and PFOS at 180 ng/L.

Table 5 - Background Values – Pilot Study Wells B-2 and B-4

	EC (umhos/cm)		pH (units)		TBA (ug/L)		1,4-Dioxane (ug/L)	
	B-2	**B-4**	**B-2**	**B-4**	**B-2**	**B-4**	**B-2**	**B-4**
Mean	1,680	1,801	7.24	6.93	15.64	29.43	<8.8 to <42	35.62
Median	1,722	1,835	6.95	6.75				
Lower Quartile	1,574	1,716	6.87	6.59				
Upper Quartile	1,797	1,867	7.51	7.20				
Minimum	1,385	1,673	6.50	6.20				
Maximum	1,858	1,926	9.10	8.20	28.00	43.5	<42	38.60

REPORTING

When reporting the data, the Discharger shall arrange the information in tabular form so that the date, the constituents, and the concentrations are readily discernible. The data shall be summarized in such a manner as to illustrate clearly the compliance with this Order. The results of any monitoring done more frequently than required at the locations specified in the MRP shall also be reported to the Central Valley Water Board.

As required by the California Business and Professions Code Sections 6735, 7835, and 7835.1, all reports shall be prepared by a registered professional Civil Engineer or Geologist or their subordinate and signed by the registered professional.

The Discharger shall **submit electronic data reports**, which conform to the requirements of the California Code of Regulations, Title 23, Division 3, Chapter 30. The reports shall be submitted electronically over the internet to the GeoTracker database system in accordance with the schedule established in **Table 1**. The pretest sampling and monthly sampling results shall be submitted no more than **30 days** after the date of sampling. The final Pilot Study Report shall be submitted no more than **60 days** after the last day of the ozone injection. Additionally, a Post-Treatment Report shall be submitted which provides sampling results collected at quarterly intervals (**90 days, 180 days, 270 days and 360 days**) following termination of ozone injection.

The Pilot Study Report shall include the following minimum information:

1. For each groundwater monitoring point addressed by the report, a description of:

   i) The time of water level measurement;

   ii) The type of pump or other device used for purging;

   iii) The elevation of the pump intake relative to the elevation of the screened interval;

   iv) The method of purging used to stabilize water in the well bore before the sample is taken including: the pumping rate; the equipment and methods used to monitor field pH, temperature, and conductivity during purging; results of pH, temperature, conductivity, and turbidity testing; and the method of disposing of the purge water;

   v) The type of pump, or other device, used for sampling, if different than the pump or device used for purging; and

   vi) A statement that the sampling procedure was conducted in accordance with the approved Sample Collection and Analysis Plan.

2. A map or aerial photograph showing the locations of injection points and monitoring points.

3. Field data sheets documenting instrument calibration, water level measurements, purging and sampling information, field parameter measurements, and other field activities.

4. Tabulated monitoring data for all monitoring points and constituents for groundwater. Concentrations below the laboratory reporting limit (RL) shall not be reported as “not detected” (“ND”) unless the RL is also given in the table. Otherwise they shall be reported “<” the RL (e.g., <0.10).

5. Laboratory statements of results of all analyses evaluating compliance with requirements.

6. An evaluation of the concentration of each monitoring or COC parameter as compared to the current concentration limits.

7. All monitoring and COC parameters shall be graphed to show historical trends at each monitoring point and background monitoring point, for all samples taken within at least the previous five calendar years. Each such graph shall plot the concentration of one or more constituents for the period of record for a given monitoring point or background monitoring point, at a scale appropriate to show trends or variations in water quality. The graphs shall plot each datum, rather

than plotting mean values.

8. All historical monitoring data for which there are detectable results, including data for the previous year, shall be submitted in tabular form in a digital file format such as a computer disk. The Central Valley Water Board regards the submittal of data in hard copy and in digital format as "...the form necessary for..." statistical analysis [Title 27, section 20420(h)], that facilitates periodic review by the Central Valley Water Board.
9. A written summary of the monitoring results.

The Post-Treatment Report shall include all applicable elements required by the Pilot Study Report, with the minimum additional following information:

1. An assessment of post injection COC concentrations and whether any indications of rebound have been noted.

2. If the 2nd phase of the Pilot Study demonstrates that ozone injection has adequately treated impacted groundwater, a proposal for the implementation of full-scale ozone injection for treatment of groundwater, and any changes which may be made to the ozone injection remediation strategy as determined from the results of the Pilot Study.

A letter transmitting the Pilot Study Report and the Post-Treatment Report shall accompany the reports. Such a letter shall include a discussion of requirement violations found during the reporting period, and actions taken or planned for correcting noted violations, such as operation or facility modifications. The transmittal letter shall contain the penalty of perjury statement by the Discharger, or the Discharger's authorized agent, as described in the Standard Provisions General Reporting Requirements Section B.3.

The Discharger shall implement the above monitoring program on the first day of the month following adoption of this Order.